Canal configurations of mandibular anterior teeth in Erbil city by CBCT

Azhin Mustafa Goran[(1)], **Fareed Hanna Rofoo**[(1)]

Background and Objectives: The aim of this study is assessment of the canal morphology of mandibular anterior teeth, the gender differences and between right and left side of them in adult Iraqi Kurdish people using cone-beam computed tomography (CBCT).

Subjects and methods: CBCT). Subjects and methods: A retro and prospective study of canal configuration of mandibular anterior teeth by CBCT of a total of 194 subjects 72 males (37.1%) and 122 females (62.9%). Mandible anterior teeth including six teeth for each of 388 central incisor, lateral incisor and canine were analyzed in the database. For classification of morphology of the root canal, Vertucci method was used.

Results: There was a non-significant difference between genders. Percentage of more than one canal was 33.1% in central incisors, 33.1% in lateral incisors, and 9.2% in canines. The most common root canal morphology type in all mandibular anterior teeth was type I. Type III was the second most common type in mandibular incisors. Type V was the second most common type in mandibular canines.

Conclusion: Canal configuration is subjected to racial and ethnic variations and studying it is important for dental practitioner to understand the variations in root canal morphology of anterior teeth in order to overcome problems when performing endodontic treatment. More studies are needed to further define morphological characteristics of roots of mandibular anterior teeth in Kurdish population.

Keywords: mandibular incisors; mandibular canines; root canal; canal configuration; canal morphology; canal types; cone-beam computed tomography.

[(1)]Department of Oral Surgery. College of Dentistry, Hawler Medical University, Erbil, Iraqi Kurdistan Region.

Correspondence: Azhin Mustafa Goran, email: ajin.mawa@gmail.com

Introduction

Numerous studies have demonstrated that the anterior teeth (central incisors, lateral incisors and canines) in the mandible can significantly vary in the root canal configuration. There are differences in the root canal morphologies in different populations.[1-4] Canal configurations in mandibular anterior teeth may significantly differ with regard to ethnicity, sex, and race. A mandibular anterior tooth may have extra canals and a kind of canal configurations.[5] The morphology of the root canal systems of mandibular incisor teeth may be varied depending on the population.[6] Previous studies have shown that a high percentage of mandibular incisor teeth have more than one root canal. The incidence of mandibular incisor teeth with more than one canal has been reported to range from 11.5% to 50%.[7,8] Mandibular incisors most often have a single root; however, a dentinal bridge may sometimes divide the root into two canals, and further variations may be seen.[9]

Previously believed that mandibular incisors usually have just one root canal.[5,10-12] However, studies have revealed a high variation of root canal morphology among mandibular anterior teeth.[5,11,12] In 1965 the study carried out by Rankine et al.[13] showed high

prevalence of two canals in the mandibular incisors. An accessory root canal is not uncommon finding that carries out in the primary and permanent human dentition. External insults such as trauma stimulate ethnicity, age, developmental anomalies and the formation of reparative dentine, caries, periodontal disease and restorative procedures have been proclaimed as participating factors to the creation of this anatomical variation.[14]

One previous study reported the prevalence of two canals to be 7.6% for central and 4.17% for lateral incisors.[10] Somalinga Amardeep et al.[15] studied that root canal morphology varies according to race. For example, in Iranian population,[4] a relatively high percentage of mandibular canines had more than one root canal. According to Geduk et al.16 the incidence of the second canal in permanent mandibular incisors was relatively high in females, in contrast to the Liu et al.[3] study, which reported that a slightly higher occurrence of the second canal was found in males than in females. Carrotte1[7] reported more than 40% of mandibular incisors have two canals and more than 1% has two separate apical foramina.[17] According to another study, Karagoz-Kucukay[18] 15% of the teeth studied showed a bifurcated canal, 7.7% had a lateral canal, and 25% had an accessory canal, which was defined as a secondary canal that emanated from the main canal and travelled at an angle alongside it before exiting into the periodontal ligament space. Liu et al.[3] reported that gender was not significantly related to variations in tooth or root canal morphology in the mandibular anterior teeth. Additional type introduced by Ng et al[19] two root canals leave the pulp chamber, join again as single root canal, which separates into two branches and end as two foramina. This finding was also reported by Kartal and Yanikoglu,[7,20] Gulabivala et al,[21] Ng et al,[19] and Sert and Bayirli.[22] The aim of this study is assessment of the canal morphology of mandibular anterior teeth by using cone-beam computed tomography (CBCT) in Kurdish people and compare it with other populations.

Materials and subjects

A retro and prospective study included a total of 194 Iraqi Kurdish subjects (72 males and 122 females) with age between 16 and 40 years old were examined for canal configuration of anterior mandibular segment using CBCT. The data were collected from two private Smart Center for Oral and Maxillofacial Radiology, and Hollywood Smile Studio for Implant and Cosmetic Dentistry in Erbil city, using radiology centers have NEWTOM GIANO CBCT (Verona, Italy, 2016), over the study period from November 2018 to May 2019. Inclusion and exclusion criterias were; sound, fully developed teeth with no pathologies. From more than 240 CBCTs only 194 of the CBCTs met the inclusion criteria of this study. Federation Dentaire International system was used for tooth numbering because this system is acceptable to computer language.[23,24] The Vertucci method of classification was used as shown in Figure1.[1,10,12,25] For each case the images were created in DICOM format and

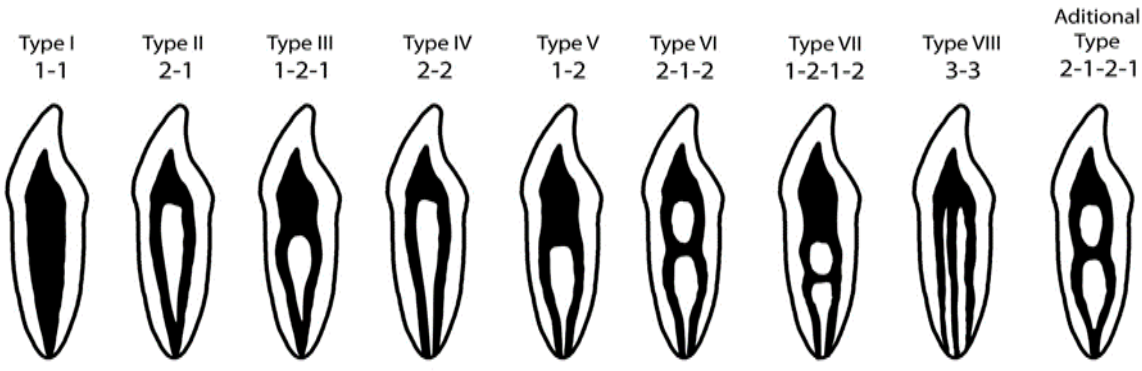

Figure 1: Types of root canal systems classified by Vertucci and the additional type used.6

evaluated by NNT (8.2) software viewer program. Each tooth evaluated by axial, coronal, sagittal in multiplanar (MPR) reconstructions, with a cutting interval of 0.15mm to get final result of morphology and the canal configuration was classified to the proper type of canal configuration as is shown in Figure 2.

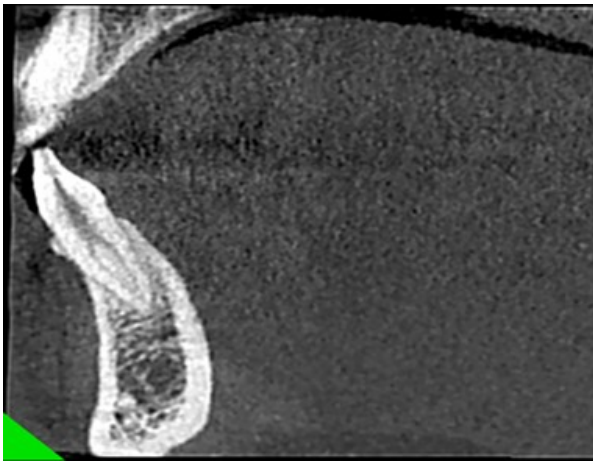

Figure 2: CBCT Sagittal view of lower left lateral, shows type III canal configuration.

Statistical analysis of data was performed by using a commercial software package SPSS version 25 for Statistics (SPSS Inc., Chicago, IL, USA). Chi-square ($\chi 2$) test was used to compare the frequency of categorical variables and to demonstrate statistical significance. All results where the probability of the null hypothesis was less than 5% ($p<0.05$), were considered statistically significant.

Results

194 subjects were enrolled in this study, 72 males (37.1%) and 122 females (62.9%). The age ranged between (16-40 years). The canal configuration of a total number of 1164 of teeth was studied, divided into six teeth for each of 388 central incisor, lateral incisor and canine. There is non-significant difference in male and female in types of canal configuration, is shown in Table 1.

The first most common morphology in both quadrants and gender was Type I with a frequency 77.8% in male and 73.2% in female, and the second most common morphology in both quadrants was Type III with a frequency 11.6% in male and 1.5% in female. Types IV, VI, VIII, and IX (additional type) were absent as is shown in Table 1.

In mandibular central incisors types I, II, III, V, and VII were observed, as is shown in Table 2. Type I represented the most common canal morphology in both sides and both genders by frequency 67%, as is shown in Table 2. Right central incisor Type I in male was more than female, while in left side was less than female as is shown in Table 3. The second most common canal morphology was the Type III in both groups and both quadrants by frequency 22.6 % as is shown in Table 2. It was seen in females more than males and right side less than left side, as is shown in Table 3. Type II was only seen in male. However, Type VII was seen in female both had small percentage, as is shown in Table 2 and 3.

The mandibular lateral incisors, right side presented Types I, II, III, V, and VII, but left side represented Types I, III, and V. The most common canal morphology was Type I in both sides and both genders (67%) is shown in Table 2, in right side in males was more than females, but in left side was less than in females, is shown in Table 3. The second most common canal morphology was the Type III in both groups and both quadrants with close as is shown in Table 2.

The presence of Type V was recorded in 13.8% in both genders as is shown in Table 2. Types II and VII were observed in a small percentage in right side (1%, 1.4% respectively) while were not observed in left quadrant as is shown in Table 3.

The mandibular canines presented only Types I, II, III, and V in right side. However left side had I, III, V, and VII. In both quadrants and genders Type 1 was the most common canal morphology (90.7%) as is shown in (Table 2). The second most common canal morphology was the Type V in both groups and both quadrants with close as is shown in (Table 2). In right side Types II (1%), III (1%), and V (7.2%) were observed but Type VII had zero percentage as is shown in (Table 3). In the left side a small percentage of Types III (2.1%), V (6.2%), and VII (1%) were observed but Type II had had zero percentage as is shown in Table 3.

Table 1: Gender distribution and percentage of types of root canal morphology of anterior mandibular teeth.

Sex		Types of Canal Configuration				
		I	II	III	V	VII
Male	No.	336	6	50	38	2
	%	77.8	1.4	11.6	8.8	0.5
Female	No	536	2	114	72	8
	%	73.2	0.3	15.6	9.8	1.1
Total	No	872	8	164	110	10
	%	74.9	0.7	14.1	9.5	0.9

*Non-significant

Table 2: Distribution and percentage of types of root canal morphology of anterior mandibular teeth in both genders and quadrants (%).

Tooth Name	Types of Canal Configuration				
	I	II	III	V	VII
Central	67	1	22.6	7.7	1.8
Lateral	67	0.5	18	13.9	0.7
Canine	90.7	0.5	1.5	6.7	0.5

Table 3: Distribution and percentage of types of root canal morphology of anterior mandibular teeth.

Tooth No.	Gender	Types of Canal Configuration									
		I		II		III		V		VII	
43, n (%)	M	70	(97.2)	0	0	0	0	2	(2.8)	0	0
	F	106	(86.9)	2	(1.6)	2	(1.6)	12	(9.8)	0	0
	Total	176	(90.7)	2	(1)	2	(1)	14	(7.2)	0	0
33, n (%)	M	68	(94.4)	0	0	2	(2.8)	2	(2.8)	0	0
	F	108	(88.5)	0	0	2	(1.6)	10	(8.2)	2	(1.6)
	Total	176	(90.7)	0	0	4	(2.1)	12	(6.2)	2	(1)
42, n (%)	M	52	(72.2)	2	(2.8)	8	(11.1)	8	(11.1)	2	(2.8)
	F	76	(62.3)	0	0	26	(21.3)	20	(16.4)	0	0
	Total	128	(66)	2	(1)	34	(17.5)	28	(14.4)	2	(1.4)
32, n (%)	M	46	(63.9)	0	0	14	(19.4)	12	(16.7)	0	0
	F	86	(70.5)	0	0	22	(18)	14	(11.5)	0	0
	Total	132	(68)	0	0	36	(18.6)	26	(13.4)	0	0
41, n (%)	M	56	(77.8)	2	(2.8)	10	(13.9)	4	(5.6)	0	0
	F	80	(65.6)	0	0	30	(24.6)	8	(6.6)	4	(3.3)
	Total	136	(70.1)	2	(1)	40	(20.6)	12	(6.2)	4	(2.6)
31, n (%)	M	44	(61.1)	2	(2.8)	16	(22.2)	10	(13.9)	0	0
	F	80	(65.6)	0	0	32	(26.2)	8	(6.6)	2	(1.6)
	Total	124	(63.9)	2	(1)	48	(24.7)	18	(9.3)	2	(1)
Total	M	336	(77.8)	6	(1.4)	50	(11.6)	38	(8.8)	2	(0.5)
	F	536	(73.2)	2	(0.3)	114	(15.6)	72	(9.8)	8	(1.1)

*Non-significant

Discussion

This study used CBCT scanning to explore root canal morphology of mandibular anterior teeth in Kurdish people. It provides an anatomical description of the mandibular anterior teeth (central incisors, lateral incisors, and canines) based on a retrospective and prospective analysis of CBCT images, which is as accurate as the canal staining and clearing technique in identifying root canal morphology.

Results showed there a non-significant difference between genders. This finding is quite opposite to that studies that done by Sert and Bayirli,22 Altunsoy et al.[2] and Lin et al.[26] which reported a statistically significant difference between genders for the incisors.

The incidence of the presence of a second canal in females higher than those of males in this study. However in Turkish6 and Chinese[5] population was higher in males than in females. Most of the mandibular anterior teeth had Type I canal configuration. Among the double canal teeth, Type III in central and lateral incisor, but in canine Type V occurred predominantly. Types IV[25,27,28] VI, VIII,[1-8,22,25-36] and IX (additional type) did not occur, but Type IX (additional type) in studies with Zhengyan et al.[5] Ying et al.[29] and Caliskan et al.[28] in central, Younong and Bao-li,[27] Sert et al.[33] and Arslan et al.[6] was present, as is shown in Table 4.

The incidence of second canal in mandibular incisors in this study was 33.1%, which was in accordance with the finding of Caliskan et al.[28] 31.37% in Turkey, and Rahimi et al[36] 36.62% in Iran. These data were higher than those of Vertucci[25] 27.5% in USA and Al-Qudah and Awawde[32] in Jordan 26.2%, Liu et al.[3] in China 13.2.%, Miyashita et al[31] in Japan 12.4% and Madeira and Hetem[8] in Brazil 11.6%, and lower than those of Kartal and Yanikogulu[7] 45% and Sert et al.[33] 65.3% in Turkey. The incidence of second canal in mandibular canine in our study was 9.2%, which was similar to Soleymani et al.[35] in Iran 9.4% higher than those results of Altunsoy et al.[2] in Turkey 4.4%, Ying et al.[29] in China 2.97% and Rahimi et al.[36] in Iran 8.4%, and clearly lower than those Caliskan et al.[28] 19.6%, Sert and Bayirli[22] 23.5% in Turkey and Aminsobhandi et al.[4] in Iran 28.7%. The differences among the studies maybe due to racial difference.[3,7,8,25,28,31-33,36] Another possible reason might be that the examined teeth in the other studies were extracted teeth,[7,8,25,28,31-33,36] in this and those study they were living teeth by CBCT.[2-4,29,35] These differences may result in different frequencies of root canal configurations. In this and most other previous studies[1-8,12,15,22,25-37] incidence of Type I canal configuration according to Vertucci[25] canal classification is the most common type, as is shown in Table 4.

In this study mandibular central incisor Type I was 67% which was much higher than the result of Sert et al.[33] 32.5% in Turkish population by different examination technique, and higher than Arslan et al.[6] 51.9% also in Turkish population by same examination technique but with difference sample size and racial group. The second most common canal type in present study, Vertucci,[25] Arslan et al.[6] Popovic et al.[1]and Da Silva et al.[37] was Type III by frequency 22.6%, 22%, 41.6%, 21.6% and 25.5% respectively. While Type II was the second most common type in these study Madeira and Hetem,[8] Sert and Bayirli,[22] Aminsobhandi et al.[4] and Sert et al.[33] in frequency 11.3%, 15.5%, 11.3%, and 27.5% respectively, as is shown in Table 4.

In current study the mandibular lateral incisor showed Type I in 67% which was much higher than the result of Sert et al.[33] 36.8% and Arslan et al.[6] 52.9% in Turkish population. The second most common canal type in present study, Vertucci,[25] Arslan et al.[6] Popovic et al.[1] and Da Silva et al.[37] was Type III by frequency 18%, 15.52%, 42.3%, 18.4% and 25.5% respectively. In a study by Madeira and Hetem[8] in frequency 11.8% Type II was the second most common type, but Aminsobhandi et al.[4] showed that Type IV was the second most common type, as is shown in Table 4.

This study showed that in mandibular canine Type I is the first most common type followed by Type V with frequency 6.7% and this result goes with Popovic et al.[1] in Serbian population with frequency 92.9% and 5.8% respectively, which is against a study done by Liu et al.[3] in Chinese population and Sert and Bayirli[22] in Turkish

population Type II and Somalinga Amardeep et al.[15] in India population Type III was second most common type by frequency 6.11% and 13.6% respectively, as is shown in Table 4.

Table 4: Percentage of different root canal configuration types in mandibular anterior teeth found in previous studies and present study.

Region and year of study		Sample	Teeth name	Method	Types of canal configuration %								
					I	II	III	IV	V	VI	VII	VIII	IX
Vertucci[25]	USA 1984	100	Central	Staining and clearing	70	5	22	3	0	0	0	0	0
		100	Lateral		75	5	18	2	0	0	0	0	0
		100	Canine		78	14	2	6	0	0	0	0	0
Al-Qudah and Awawde[32]	Jordan 2006	450	Central	Staining and clearing	73.8	10.9	6.7	5.1	3.6	0	0	0	0
Sert et al.[33]	Turkey 2004	200	Central	Staining and clearing	32.5	27.5	27	10	0.5	0	0	0	2.5
		201	Lateral		36.8	26.9	26.4	9.5	0	0	0	0	0.5
Aminsobhandi et al.[4]	Iran 2013	632	Central	CBCT	72.7	11.3	4.7	7.7	3.6	0	0	0	0
		614	Lateral		70.6	7.1	3.7	15.4	3.2	0	0	0	0
		608	Canine		71.8	10.8	2.8	12.8	2.3	0	0	0	0
Arslan et al.[6]	Turkey 2015	185	Central	CBCT	51.9	4.3	41.6	0	0.5	0	0	0	1.6
		189	Lateral		52.9	2.6	42.3	0	1.6	0	0	0	0.5
Popovic et al.[1]	Serbian 2018	296	Central	CBCT	73	4.7	21.6	0.7	0	0	0	0	0
		294	Lateral		73.5	5.4	18.4	0.7	2	0	0	0	0
		312	Canine		92.9	0.6	0.6	0	5.8	0	0	0	0
Zhengyan et al.[5]	China 2016	3375	Central	CBCT	96.3	0.1	3.7	0.15	0.8	0	0	0	0
		3257	Lateral		89.4	1.05	7.7	0.3	1.15	0	0	0	0
		3014	Canine		95.8	0.7	2.1	0.2	0.4	0	0	0	0
Altunsoy et al.[2]	Turkey 2014	1582	Central	CBCT	84.5	0.3	0.8	4.2	10	0	0	0	0
		1603	Lateral		80.2	1.8	1.7	5.4	12.1	0	0	0	0
		1604	Canine		92.8	2.1	1.2	1.35	2.65	0	0	0	0
Han et al	China 2014	1286	Central	CBCT	84.3	3.4	6.5	1.2	3.9	0.7			
		1294	Lateral		72.6	4	15.5	2.3	5	0.4			
		1291	Canine		93.7	0.6	3.3	0	0.5	0	0	0	0
Soleymani et al.[35]	Iran 2017	300	Canine	CBCT	89.7	3.7	5.7	0	1	0	0	0	0
Rahimi et al.[36]	Iran 2013	186	Central	Staining and clearing	64.5	18.3	16.7	0.5	0	0	0	0	0
		126	Lateral		61.7	16.4	21.1	0.8	0	0	0	0	0
		149	Canine		91.6	6.1	2.3	0	0	0	0	0	0
Da Silva et al.[37]	Brazil 2016	200	Central	CBCT	64.5	0	18	0	14.5	3			
		200	Lateral		60.5	0.5	25.5	0	12	1.5			
Somalinga Amardeep et al.[15]	India 2014	250	Canine	CBCT	79.6	3.2	13.6	0	2	1.6	0	0	0
Liu et al.[3]	China 2014	786	Central	CBCT	91.1	2.0	5.3	1.3	0.3	0	0	0	0
		785	Lateral		82.5	3.9	10.4	2.8	0.3	0	0	0	0
		131	Canine		91.6	6.11	2.29	0	0	0	0	0	0
Present study	Kurdistan	388	Central	CBCT	67	1.	22.6	0	7.7	0	1.8	0	0
		388	Lateral		67	0.5	18	0	13.9	0	0.7	0	0
		388	Canine		90.7	0.5	1.5	0	6.7	0	0.5	0	0

Conclusion

There was a non-significant difference between genders in morphology of canal. The most common root canal morphology type in all mandibular anterior teeth was type I. Type III was the second most common type in mandibular incisors. Type V was the second most common type in mandibular canines.

Canal configuration is subjected to racial and ethnic variations and studying it may help clinicians understand the variations in root canal morphology of anterior teeth in order to overcome problems associated with shaping and cleaning procedures because the existence of a second canal in mandibular anterior teeth are rarely apparent on clinical radiographs, and routine endodontic procedures from the lingual approach fails to reveal the presence of the second canal.[38]

More studies are needed to further define morphological characteristics of roots of mandibular anterior teeth in Kurdish population.

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Conflicts of interst

The authors reported no conflicts of intersts.

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